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which belongs exclusively to the few who have appropriated the latest discoveries of the sciences. We are dealing with what has its place in the realm of common experience. Men, plain men generally, are more or less at home in this realm, and we can not assume that generally received opinions are wholly to be disregarded. If we speak to such men in an unknown tongue, if we describe to them their familiar experiences in abstract and unfamiliar language, they will certainly not understand us, and any answers they may make to our questions can not be of service to us. It is quite likely that, by so speaking, we may prevent even our colleagues, who may have a language of their own, from understanding us, and that we may give rise to profitless discussion. It is not impossible that we deceive ourselves as well as others, contenting ourselves with words and phrases, when our whole endeavor should be to bring clearly before ourselves the most concrete and commonplace experiences, and to overlook none of their aspects.

GEORGE STUART FULLERTON.

COLUMBIA UNIVERSITY.

CONSONANCE AND DISSONANCE[1]

THE facts of consonance and dissonance imply a large number of psychological problems: of sensory perception, of representation, of judgment, and of feeling—problems which, to a great extent, are capable of exact experimental analysis. In the historical development of these problems, the psychological point of view has but lately been differentiated from the metaphysical, the physical, and the physiological.

Helmholtz, on the basis of modern epistemology, first treated the subject in a purely empirical and scientific manner. Psychologically speaking, he left to us numerous intricate, but yet not hopeless tasks. His theory puts the main stress upon the harmonic *overtones,* their coincidences and mutual disturbances. Though modern criticisms of this theory, such as that of Stumpf and Lipps, overshoot the mark, the theory itself is far from being completely satisfactory. It does not explain the facts of tone-combinations with no, or with only a few, overtones.

Lipps's theory of unconscious rhythms is more metaphysical than scientific, and is not in accordance with ascertained facts. The theory of "fusion," held by Stumpf, is based upon interesting experimental results. However, aside from some discrepancies with experience, it recurs too prematurely to a physiological hypothesis and neglects a complete analysis of the conscious data.

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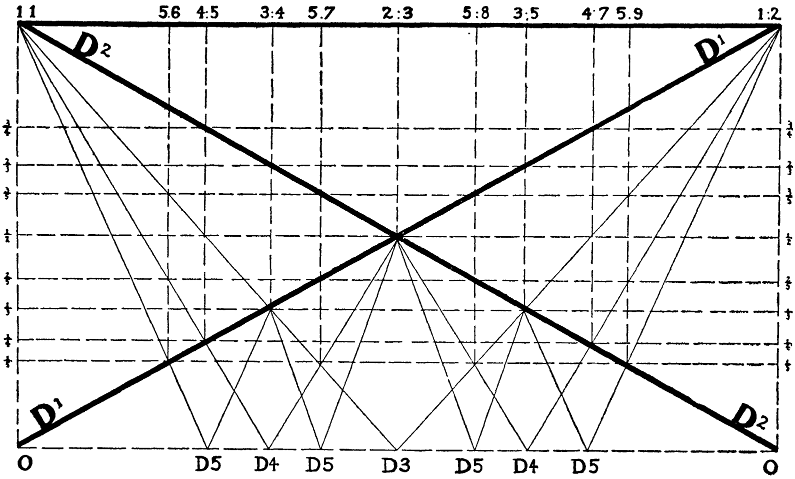
[1] This article is a summary of two lectures, given (with demonstrations) before the New York Branch of the American Psychological Association, and before the late meeting of this association at Cleveland.

In order to analyze all the phenomena, which the hearer consciously perceives at different intervals, the writer tested the matter with a large number of intervals and with independent subjects having no knowledge of the objective relations. Very soon he noticed the fundamental importance of the difference-tones for the perception of all the degrees of consonance and dissonance. Even two simple fundamentals regularly produce 5 difference-tones, the vibration-numbers of which are to be found by a continuous subtraction of the already existing tones. Thus, for instance, the minor third, 500 : 600 gives the difference-tones, $D_1 = 100$, $D_2 = 400$, $D_3 = 300$, $D_4 = 200$, $D_5 = 100$ (coincident with D_1).



In the accompanying chart the upper horizontal line symbolizes the continuous enlargement of an interval, starting from the unisone (1 : 1), passing through the two thirds, the fourth, the natural tritone (5 : 7), the fifth, the two sixths, the natural (4 : 7) and the minor seventh, to the octave (1 : 2). All of the changes of the difference-tones, corresponding to this range of intervals, are represented by the unbroken lines below the upper line. The vertical dimension of the figure signifies the pitch of the difference-tones as it increases or diminishes between the vibration-number zero and that of the lower fundamental. It is obvious that consonant intervals are characterized by exceptional relations of all their partial tones.

The general law holds that a difference-tone is related to every other simultaneous tone (either a primary or a combination-tone) in exactly the same manner as two simultaneous primary tones are related to each other. They coincide and strengthen each other, if they are of the same pitch. They give beats, roughness, and noises, they produce an intermediate tone, and make each other lower or higher, if they are near enough together. Now, the phenomena, due to the difference-tones, are in exact correspondence to the degrees of consonance and dissonance. The most perfect *consonances* (unisone and octave) have no distinct difference-tone at all. The more imperfect the consonance, the larger the number of difference-tones, and the greater the consequent danger of mutual disturbances. The fundamental phenomenon of all *dissonance* consists in the existence of a *mistuned unisone* at the bottom of the total acoustic complex. As regards the consonances and their mistunement: the purer the interval, the more distinct and intensive (the clearer and smoother) are the remaining difference-tones, most particularly the "characteristic" one, which always corresponds to the ratio-number 1.

In the concrete perception of tone-combinations—on account of the relative frequency of the intervals and their similarity to single musical sounds—several associative factors cooperate.

The objections made by Lipps and Stumpf to this theory neglect these associative factors. On the other hand, Stumpf, in his discussion of the theory, treats as being dissonant some intervals, such as 5:7, which originally are characterized in the sense of imperfect consonance, and only for historical reasons are excluded from our musical system. Finally the immediate perception of consonance and dissonance is not independent of the absolute pitch. Psychologically speaking, consonance and dissonance seem to have originated within the limits of the human voice.

The relations of difference-tones that we have described systematically explain the fundamental conditions of the real phenomena of fusion and many other facts, which Stumpf's theory does not pretend to explain; for instance, the dissonance of the excessive triad like *c-e-as*.

Successive tones can be called consonant or dissonant only in a translated sense of the word. However, several of the phenomena corresponding to them, like the facts of tonica, are in part conditioned by the laws of perception of simultaneous tones.[2]

FELIX KRUEGER.

UNIVERSITY OF HALLE, GERMANY.

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[2] Full reports of the author's experiments and theory are to be found in *Philosophische Studien,* Vols. 16, 17 (1900–1901); *Archiv für die gesamte Psychologie,* Vols. I., II. (1903); *Psychologische Studien,* Vols. I., II., IV., V. (1906–1910).